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PATENT- OG VAREMÆRKESTYRELSEN

A Computer Based

Sample Measurement System for Industrial Wood

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Chapter 1

The system

This chapter sets up a specification for an automated vision system. The system is to complete sample measurements of industrial wood at Swedish wood processing industries.

The system is intended to substitute for todays manual measurement practices at so-called mätbänke. This requires specification of

1. operational procedures
2. data reported by the system.

These two items together then drives the software implementation and the choice of hardware to complete a fully operational system.

1.1 Hardware

1.1.1 Generic setup

The hardware specification (Table 1.1) is given by conceptual units.

The vision system is to be mounted on and operated from a driving car. It should be possible to mount the system on any car carrying a roof rack. It should be easy to shift the system form one car to another.

The control unit is portable so that it can be brought to the office space for data transmission and further processing.

HARDWARE UNITS

1. Landmarks (LM):
   (a) Mobile visible landmarks (to be specified).
   (b) Storage for landmarks.
2. Image capturing unit (ICU) mounted on roof rack:
   (a) Stereo vision system build on two cameras.
   (b) Lights.
3. Control unit and user controls (UC) mounted in cabin:
   (a) Touch-pad/display and pointing device.
   (b) Keyboard.
   (c) Processing unit.
   (d) GPS unit.
4. Power supply (PS):
   (a) Batteries in ICU and/or outlet in car.
5. Cables:
   (a) Cables to connect items 2, 3 and 4 listed above.
6. Storage box for hardware.

Table 1.1: Hardware units.

1.1.2 Pilot project at Mörrum

A pilot project was conducted at MÖRRUM. Figure 1.1 displays a prototype of an image capturing unit mounted on a roof rack and a user control/processing unit in the cabin. The cameras are standard CCD digital cameras and the processing unit is a standard PC equipped with a frame grabber. A refined and more developed system will have the hardware units assembled in a standardized fashion for ease of use and durability.

The imagery displayed at the front page were acquired with this specific setup and demonstrates that standard hardware will suffice for an operational system.

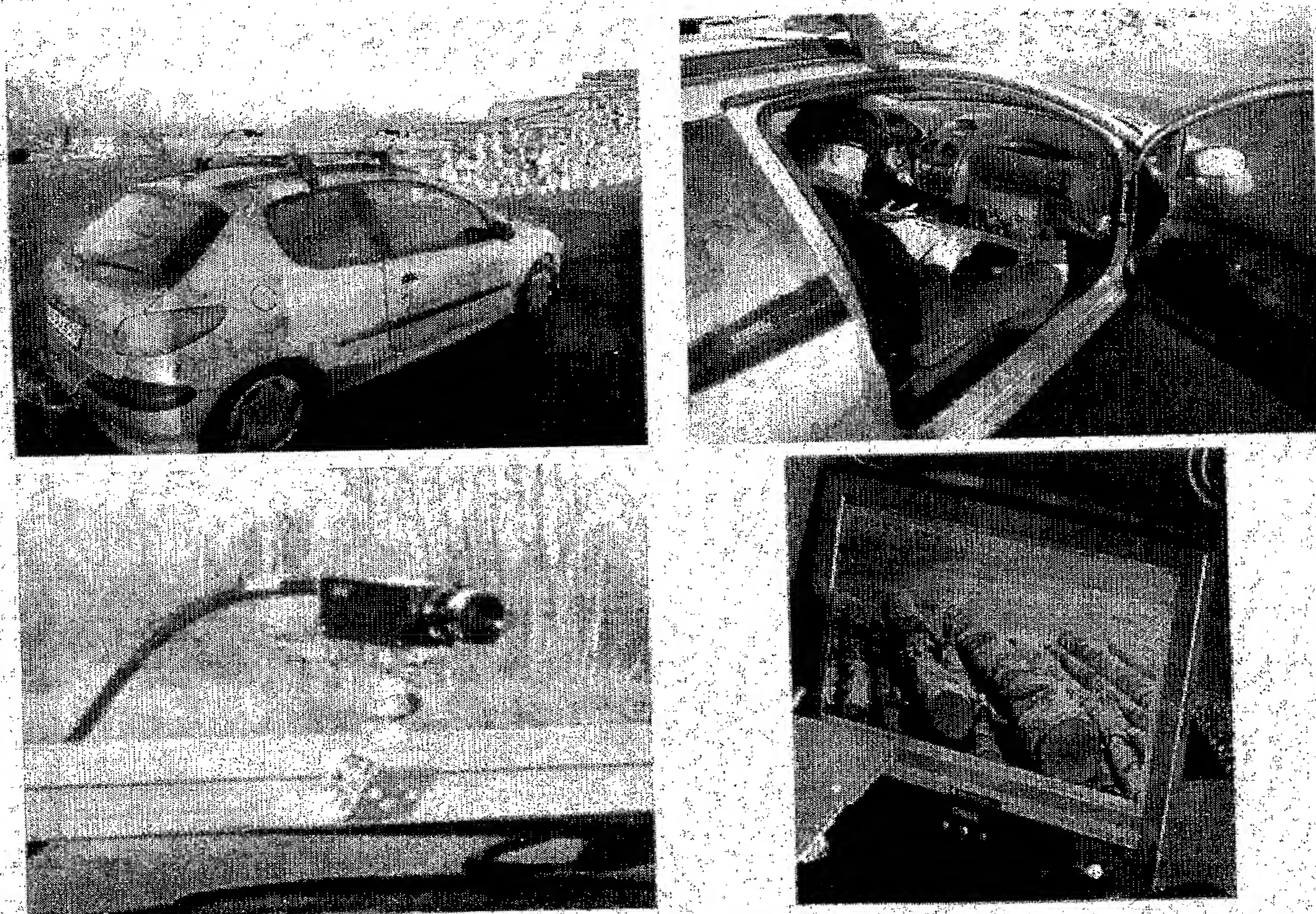


Figure 1.1: Pilot project at MÖRRUM. Upper left: Camera montage on roof rack. Upper right: PC in cabin. Lower left: Close up of CCD camera. Lower right: Close up of graphical display of camera view.

1.2 Operational procedures

1.2.1 General principle of operation

The core idea of the system is to drive around a mätbänk (Figure 1.2) and continuously capture images of the mätbänk. Based on the imagery and some basic user supervision the system then automatically measures the wood on the mätbänk. The measurements are summarized in a measurement report in digital format and on graphical display.

One cycle of driving around the mätbänk includes driving along both sides of the mätbänk in order to measure length of the logs.

Technically a mätbänk will carry one or more truck loads of wood possibly of different species. Each assembly of logs that belong together (by species, truck load, supplier, ...) is referred to as a 'batch'.

Table 1.2 specifies the overall scheme of operation. Selected items are then discussed in detail in successive sections.

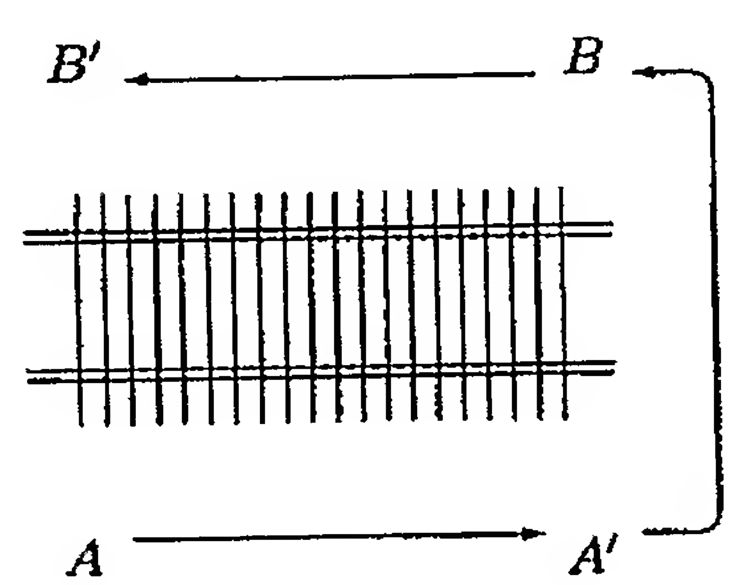


Figure 1.2: One cycle driving around a mätbänk starting at A.

OPERATIONAL PROCEDURES

1. Mount system:
   (a) ICU onto roof rack of car [if not already].
   (b) UC in cabin of car [if not already].
   (c) Connect hardware units by cables.
   (d) Power on system.
2. Prepare mätbänk:
   (a) Remove snow, dirt and branches from logs [if required].
   (b) Rearrange logs [if required].
   (c) Place landmarks.
3. Initialize system:
   (a) Enter information identifying batches on mätbänk.
   (b) Place car in operating distance from mätbänk at A.
   (c) Switch on lights [if required].
   (d) Adjust field of view of ICU.
   (e) Adjust focus and brightness/contrast of ICU cameras.
   (f) Mark off upper/lower boundary of mätbänk on display.
   (g) Verify initial estimate of logs visually [optional].
4. Drive around mätbänk:
   (a) Activate vision system. Drive $A \rightarrow A'$. Pause vision system.
   (b) Drive to B. Complete initialization steps 3d, 3e, 3f and 3g.
   (c) Re-activate vision system. Drive $B \rightarrow B'$. Deactivate vision system.

OPERATIONAL PROCEDURES *ctd.*

5. Verify measurement:
   (a) Play image sequence and check that mätbänk is within images [optional].
   (b) Mark off individual batches [if required].
   (c) Inspect from sample of images that logs are detected correctly. That is, check that log ends are detected and matched correctly. The detection result is superimposed on imagery.
   (d) If case of few mismatches, use point/click interface of UC to correct mismatches. The system re-estimates the logs.
   (e) Iterate over 5c and 5d if necessary.
   (f) Enter quality parameters for individual logs or individual batches from visual inspection of imagery or physical inspection where required.
   (g) Check summary statistics of measurement report [optional].
   (h) Accept measurement report or discard and start afresh (6).
6. Iterate over 3, 4 and 5 for each additional load of batches on mätbänk. That is, if the mätbänk is cleared and reloaded with batches while the measurement crew is at the site.
7. Unmount system:
   (a) Power off system.
   (b) Disconnect hardware units (put cables in storage box).
   (c) Unmount ICU and UC [optional].
8. Data management:
   (a) Bring portable unit of UC to office.
   (b) Identify measurement failures. Submit problematic imagery to DRALLE APS for check.
   (c) Print measurement reports [optional].
   (d) Submit measurement reports to central server.
   (e) Free up space on UC [optional].

Table 1.2: Operational procedures.

1.2.2 Mount/unmount system

The cable that connect the ICU and the UC will consist of several parts. Wires for power, control of cameras, control of lights etc. All these are put into one bundle and that connects to the ICU by 1-3 sockets. While operating the system the cable will go through an open window to the cabin. While the system is out of operation driving from one site to another the cable must be stored safely in the storage box.

1.2.3 Prepare mätbänk

To facilitate optimal performance of the vision system the log ends of the logs must to a large extend be visible and preferably also the entire outline of each separate log. Therefore rearranging some logs and cleaning up some of the logs may be necessary. If there is more than one batch on the mätbänk leaving some space between each batch is preferable.

For maximum precision placing landmarks of known size on the mätbänk is required. The landmarks are likely to be poles with standardized markings that the operator of the system brings with him/her from site to site.

Based on field tests an optimal design will be specified. The design will specify number, location and orientation of the landmarks. Observe that landmarks in upright position placed between adjacent batches on the mätbänk will serve as separators.

1.2.4 Initialize system

Initializing the system serves two purposes. One is to label the batches on the mätbänk uniquely for future reference when reports of the measurement results are generated. The labeling is supported by the GPS system

that automatically will give the name and location of the site of the actual mätbänk.

The other main purpose is to start up the image vision system. On the hardware side the orientation of the cameras are adjusted so that logs on the mätbänk can bee seen at full length (field of view). Next the lens system of the cameras are adjusted to give proper focus and brightness/contrast. Both are judged by the operator of the system using the graphical display of the views of the cameras.

On the software side the user may assist the system by marking a region of interest in the camera views. Given this region of interest the software then singles out the individual log and the user verifies the result. While driving along one side of the mätbänk the system automatically tracks the boundaries of the logs on the mätbänk and continuously singles out the individual logs.

1.2.5 Drive around mätbänk

It is crucial for the system that logs are visible at their full length and that focus on the logs remain sharp while driving around the mätbänk. The user must therefore make sure that he/she can keep the car at a fairly constant distance (deviations within 1m) from the mätbänk while driving. It is absolutly crucial that the car is driving at a suitable low speed, about 5-10 km per hour.

1.2.6 Verify measurement

Having driven all around a mätbänk the system brings the estimated logs to the display for the user to verify that logs are identified correctly. The whole sequence of imagery is available as a movie to play backwards or forwards. In case the system failed to match up the logs correctly, e.g. due to a broken log, a simple point and click interface will allow the user correct the mismatch.

Using a point/click interface or scrolling through the list of logs, imagery of each log is brought to display and the user can visually asses quality parameters and enter them into the system.

If there is more than one batch on the mätbänk and the batches were not separated by landmarks the user should also check that batches are separated correctly by the system. Again a simple point and click interface is used to mark off the batch separations.

Finally the user prompts for a measurement report on the display. Based on the report the user decides if the measurement is successful or not. The system has automated procedures to guide the user in finding measurement results of too low accuracy or outside reasonable threshold values.

1.2.7 Quality assessment of individual logs

Having the complete image sequence and logs matched up correctly the user identifies logs that have defects from the imagery and enter into the system type of defect (rot, damage, ...) and extent. This may require driving around the mätbänk looking at the logs from the cabin of the car or stepping outside to check a specific log.

No new image sequence is taken during the step.

1.2.8 Data management

The system warns the user of failures or suspicious results and the corresponding imagery should be sent to DRALLE APS for further processing and refinement of the system.

Eventually reports are printed to paper and transmitted digitally to a central server. (Refer to Section 1.7).

The user may delete imagery from the hard drive of the UC to free up space for future measurements.

1.3 Measurement report

Today there is a close correspondence between measurement practice and algorithms used to compute statistics from the actual measurements (VMR 1-99, 1-01). Also there are code lists for classification schemes (VMR 1-96).

The vision system operates different from using a caliper and a steel band since the measurements are now indirect. Technically the system builds an internal representation for each log. Based on this representation specific characteristics (length, diameter, etc) are then computed. Since the internal representation does not necessarily mimic a set of top-butt and length measurements the algorithms to compute the characteristics may take a different form than the usual algorithms but will incorporate the usual algorithms when possible.

Table 1.3 sets up the categories of information and accuracies the system must provide. The format and coding should comply with today's standards.

1.3.1 Quantities and format

Given the characteristics computed at the log level, aggregate statistics at the batch level are easily derived. Note that if there is only one batch on a mätbänk then the batch level and mätbänk level will coincide.

On the graphical display of the UC a suitable format for each load on a mätbänk is to aggregate at the batch level giving histograms of diameter/length/volume distribution and a table of total number of logs, mean diameter, mean length, total volume and mean volume. The format for printed reports should follow this format with headers that refer to the particular batch.

The format of reports for upload should be at the log level, each log being given a unique id that refer back to batch.

1.3.2 Accuracies

The statistics (diameter, volume, etc) computed from the image analysis is considered estimates from a statistical analysis. This analysis provides in itself estimates of the standard error of each quantity.

MEASUREMENT REPORT
1. Quantities: (a) Location, time, measurement crew and unique id. (b) Assortment/quality. (c) Seller and buyer. (d) Diameters (butt/top) at individual log level. (e) Length at individual log level. (f) Volume at individual log level. (g) Wood quality parameters at individual log level based on user's visual inspection. (h) *Curvature.* (i) *Bark percentage.* (j) *Damage.* (k) *Rot.* 2. Accuracies: (a) Standard error on mean diameter. (b) Standard error on mean length. (c) Standard error on mean volume. 3. Format: (a) Tables and images on graphical display of UC. (b) Tables in digital format for printing (HTML/PDF). (c) Tables in digital format for upload (XML).

Table 1.3: Measurement report. Items in *italics* (1h, 1i, 1j and 1k) are possible future developments of the system.

1.4 Quality monitoring

Besides human supervision of the measurement process (Table 1.2 item 5) the system has automated procedures that guides the user and ensures a high quality of the measurements.

These procedures are active both while the system is being operated in the field at a mätbänk and while running the system in the office.

QUALITY ASSESSMENT
1. Routines that identifies outlying summary statistics. 2. Routines that checks that required accuracies are met. 3. Routines that keeps track on how much human supervision was required to match up logs. 4. Continuous monitoring of operating system from central server.

Table 1.4: Quality assessment.

1.4.1 Routines that checks that required accuracies are met

In accordance with todays practices the system must meet some minimum accuracies on the estimates. As outlined in Section 1.3.2 it is an inherent feature of the system that standard errors are computed. Given tabular standards or algorithms for the required accuracy it is a straight forward computation to check that the required accuracy is met.

1.5 Maintenance

A functional system is made up of hardware units, software and crew each of which require "maintenance" in its own way. Table 1.5 gives an outline of the generic maintenance. For a specific hardware configuration and software version there will be specific procedures to follow. The procedures will be detailed in a booklet.

MAINTENANCE
1. ICU: (a) Check lenses/"windows" clean. (b) Check adjustment of focus, shutter time and f/stop (brightness and contrast). (c) Check lights. (d) Check socket for cable. (e) Calibrate camera from test-field [if required]. 2. UC: (a) Keep free space on static storage medium of processing unit. (b) Check touch-pad/pointing device and keyboard. (c) Software updates. 3. Crew: (a) Education of crew that operates the system.

Table 1.5: Maintenance.

1.5.1 Image capturing unit and user control

Clearly maintenance is about mechanical features of each of the hardware components and relates closely to the operational procedures.

However, camera calibration to take into account lens distortion of the vision system and verification of baseline may be necessary at regular intervals.

1.6 Range of operation

Standard equipment (caliper, steel tape, etc) for control measurements are weather proof. The vision system specified here on the other hand is high tech and is therefore more susceptible to the operation conditions.

Firstly the hardware is prone to shock and susceptible to climate. A preliminary survey on possible hardware configurations shows that a wide range of operating conditions can be met if the ICU is encapsulated properly. However, increased environmental tolerance means increased hardware cost.

Secondly the imagery must be of a certain quality to ensure successful image analysis. For that reason, extreme lighting conditions at the mätbänk, or motion blur (driving at a speed above $\sim$ 15km/h) will be limiting factors.

Table 1.6 lists limiting factors for operation that need be specified to pick the right hardware while giving a relevant range of operation for the control measurements in practice.

Range of operation
1. Temperature.
2. Humidity.
3. Illumination.
4. Driving speed.
5. "Road surface" roughness.
6. Shock tolerance.
7. Power supply.
8. GPS satellite availability.

Table 1.6: Range of operation.

1.7 Procedure for sending measurement data to SDC

After measurements have been validated they should be sent to the SDC central data facility. The procedure (outlined below) uses asymmetric (public/private) key encryption in order to assure that sensitive data is not exposed to outside parties and that DRALLE APS may monitor the use of the system for license fee settlement according to Appendix ??ithout gaining access to the actual measurement data. Two key pairs are needed: One for which the private decryption key is held by SDC and one for which the private decryption key is held by DRALLE APS.

The procedure is as follows:

1. Each batch is assigned a random, unique ID. This ID is only to be used in auditing transactions between SDC and DRALLE APS.

2. The detailed measurement data are formatted according to a format to be negotiated with SDC (probably some XML format). In the following this is referred to as the "payload".

3. The payload is encrypted with a SDC public key (for which only SDC holds the private key needed for decryption). This ensures that DRALLE APS will not obtain the detailed measurement data.

4. Some summary data on the measurements are compiled, most likely the number of logs and total volume of each batch. These data will be used by DRALLE APS to keep track of the amount of wood actually measured using the system for purposes of settlement of license fees according to Appendix ??

5. The encrypted payload and the summary are encrypted together using a DRALLE APS public key (for which only DRALLE APS holds the private key needed for decryption). This ensures that no outside parties gain access to the data e.g. by network eavesdropping.

6. The resulting encrypted data are sent to the DRALLE APS server (or a back-up server in case the main server is temporarily unreachable).

7. On the DRALLE APS server, the data is decrypted using the DRALLE APS private key. The summary data is retained by DRALLE APS.

8. The SDC encrypted payload is sent by the DRALLE APS server to the SDC, where it is decrypted using the SDC private key.

1.8 Measurement accuracy

The hardware configuration of the pilot project at MÖRRUM described previously is given in Table 1.7.

Variable	Value	
Camera constant	12.6	mm
Pixel size	$4.65 \cdot 10^{-3}$	mm
Baseline	1000	mm
Shutter speed	10^{-3}	sec
Driving speed	$10 \cdot 1000/3.6$	mm/sec
Distance to mätbänk	4000	mm

Table 1.7: Hardware configuration for pilot project at MÖRRUM.

Below is given somewhat theoretical considerations on measurement accuracy. They are based on the cautious assumption that it is only possible to measure to an accuracy of one image pixel. The computations are based on straight forward geometry and a simple simulation study, not an entire image analysis algorithm.

1.8.1 Diameter measurement at individual log level

Pixel resolution

To judge accuracy on measuring diameter we compute

$$\text{vertical plane real-world resolution} = \frac{4000\text{mm}}{12.6\text{mm}} \cdot 4.65 \cdot 10^{-3}\text{mm} = 1.47 \text{ mm/pixel}$$

which is the correspondence between a pixel in the digital imagery and vertical *plane* physical extent of objects located at the log ends (Figure 1.3). That is, moving between adjacent growth rings on a log end is close to moving a couple of pixels in the digital imagery.

Assuming that opposite points on a log end boundary are measured independently and with a one pixel accuracy, diameters are measured with a standard deviation of

$$\sqrt{1.47^2 + 1.47^2}\text{mm} = 2.1\text{mm}.$$

This number is about an oder of magnitude less than real world deviations from a pure circular cross-sectional of logs, while at the same order of magnitude as measurement accuracy of a caliper. Thus it compares well with todays diameter measurement using a caliper.

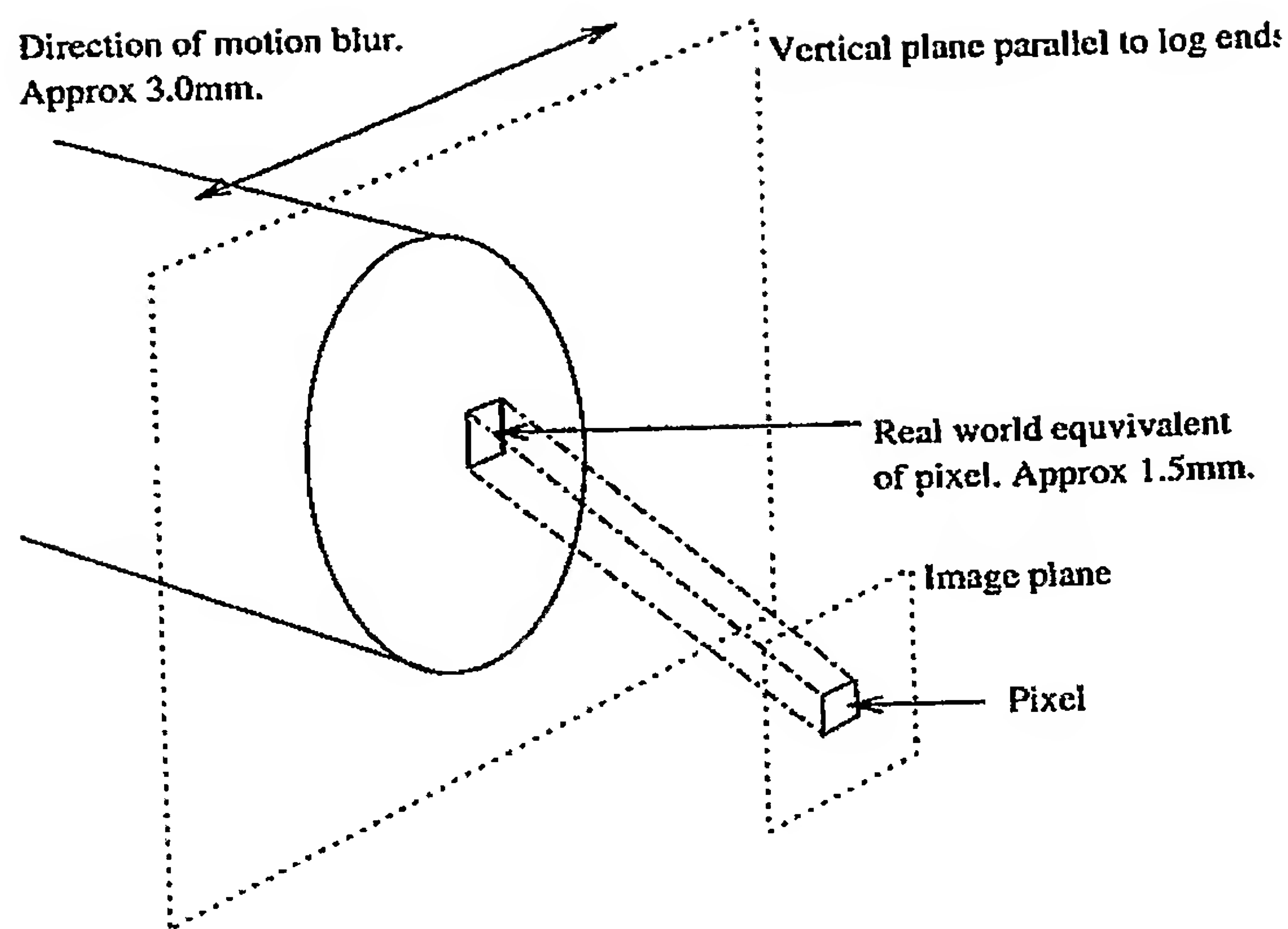


Figure 1.3: Correspondence between a pixel and real world equivalent. The image plane and the plane at the log end are parallel.

However, we may actually measure log end *areas* which may give a better volume estimation.

Motion blur

We also compute

motion blur $= 10/3.6 \cdot 1000\text{mm/sec} \cdot 10^{-3}\text{sec} = 2.8\text{mm} \sim 1.9$ pixel at log ends.

Motion blur is the effect of the camera (car) not standing still while an image is captured. The motion blur is unidirectional in the imagery (parallel to the upper and lower boundary of the image plane, Figure 1.3). It causes the light surface of a log end appear wider at the expense of the bark looking thinner.

For a given image sequence it is however possible to estimate the motion blur fairly accurately because it is known that only the car is moving. The concern then is whether 2.8mm blurs up features on the logs to such extent that correlation matching fails. It is judged that 2.8mm is not critical.

In conclusion motion blur can be adjusted for when measuring the log end boundaries and correlation matching for distance measurement (see below)

is not hampered.

1.8.2 Length measurement at individual log level

Simulation study

To judge the accuracy of length measurement consider a point on a log end that is imaged onto the images of a stereo pair (Figure 1.4). The image analysis identifies the corresponding image points and the location of the log may then estimated by re-section (intersection of dashed lines). The image points are however identified with some error so the estimated log point may not coincide with its true location.

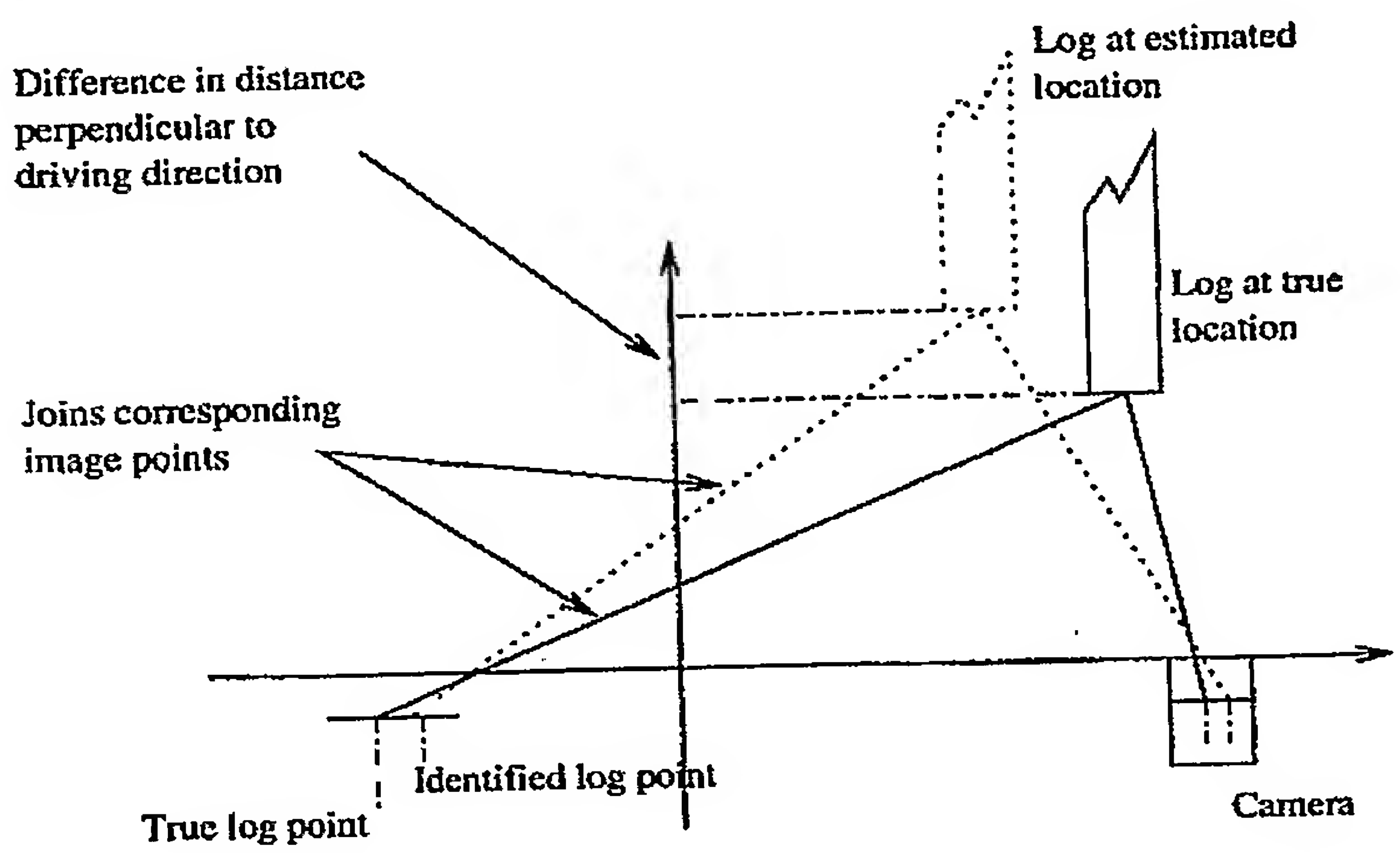


Figure 1.4: Correspondence of image points originating from the same log end point (thick line) and the principle of re-section (intersection of dotted lines).

Given the driving speed of Table 1.7 a log will however appear in more that one pair of imagery. That is, we may think of Figure 1.4 having 3 (or more) thick and dashed lines binding together corresponding image points for the camera pair located 3 (or more) at successive positions along the horizontal axis.

Based on Table 1.7 the true image points of a log for three locations (1m apart) of the camera pair were computed and normal distributed noise of a standard deviation of one pixel were added for 5000 simulations. Taking the new image coordinates as a simulation on how the system would identify

the log, the distance orthogonal to driving direction to the log end was estimated. A histogram of the simulation result is given in Figure 1.5.

The simulation is based on only one point on a log being matched up, while in the actual vision system several points will enter the estimation thus increasing accuracy. Assuming the distance measurement to opposite ends of a log are independent the standard deviation on length then becomes (conditioned error free outer orientation of the vision system)

$$\sqrt{4.84^2 + 4.84^2}\text{mm} = 6.9\text{mm}$$

which is at the same order of magnitude as measuring with a band.

1.8.3 Volume at individual log level

A first conclusion based on the above is that the accuracy of volume at the log level will compare with todays measurement practice.

However, practice now is to measure diameters 15cm from the log end to avoid the effect of butt swell. The main concern therefore is either to establish algorithms based on end diameters that corrects for butt swell or have the image analysis algorithm "crawl" in from the log ends and automatically adjust for butt swell.

1.8.4 Accuracy at batch level

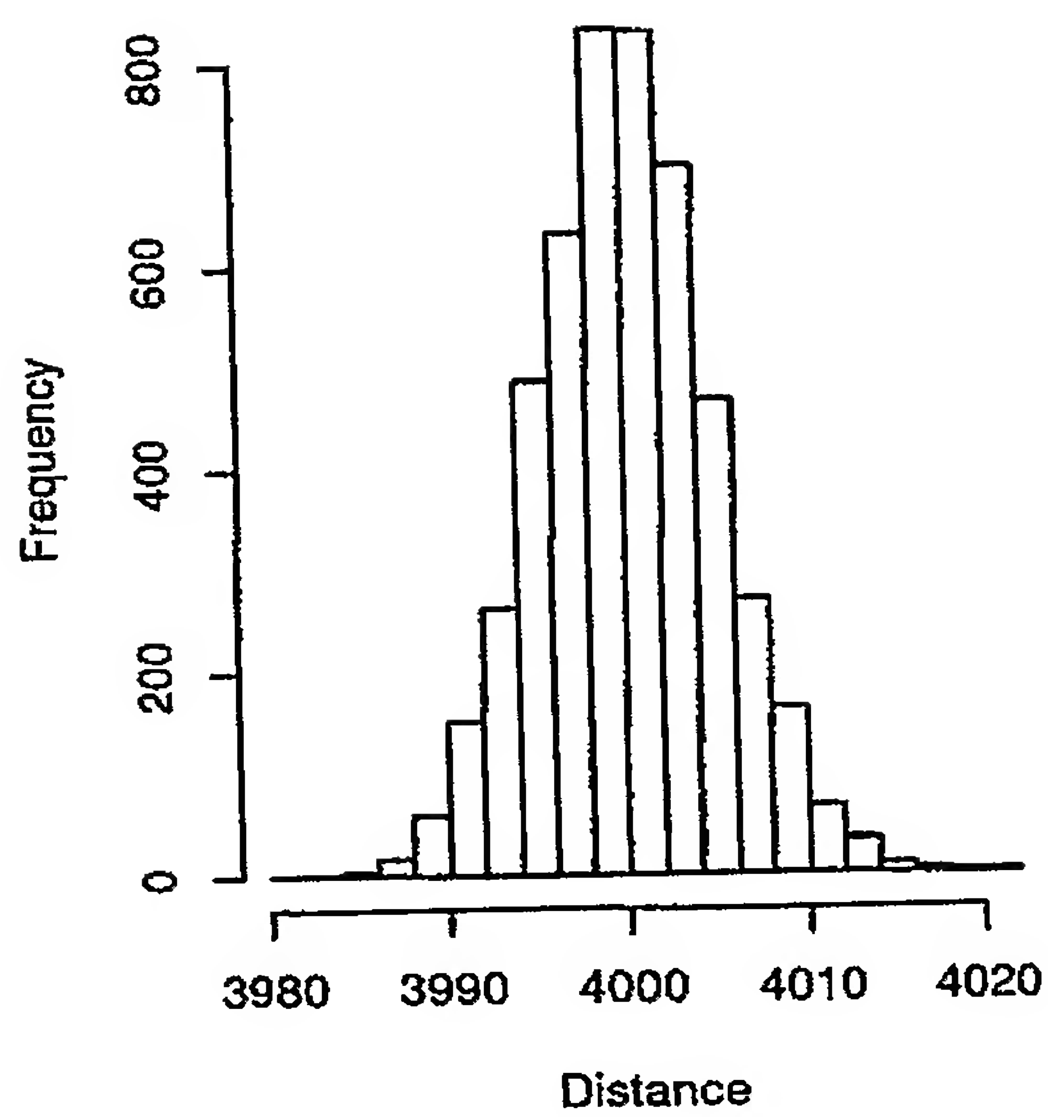
Given the human supervision of the system, there will be no omission/commission of logs. Given that diameter, length and volume at the individual log level compares with todays practice, accuracy for summary statistics at the batch level will compare as well.

1.8.5 Concluding remark

The above computations are conditioned on the viewing geometry estimated to a high accuracy. The use of landmarks is required to assure that this assumption is met.

As mentioned in the beginng the computations does not reflect the outcome of entire image analysis.

All in all the hardware configuration for the pilot project at MÖRRUM suggests a system that operates with the accuracy of todays practices.



Quantile	
5%	3992.163
25%	3996.921
50%	4000.127
75%	4003.242
95%	4008.327

Figure 1.5: Histogram of simulation result for distance measurement. True distance from log ends (mätbänk) to camera is 4000mm (cf Table 1.7). The standard deviation is 4.84mm.

Chapter 2

User interface design

The Control unit is operated through three applications

1. The "Capture application" while operating the system at a mätbänk.
2. The "Data management application" for use at the office.
3. The "Update application" for software updates of the system.

This chapter sets up a design for the graphical user interface (GUI) and explains how to use each of the applications. The design is made in accordance with the specification on operational procedures of the measurement system. Observe that the Capture application and the Data management application are designed for two different operating environment: (i) the car, and (ii) the office.

2.1 Start up

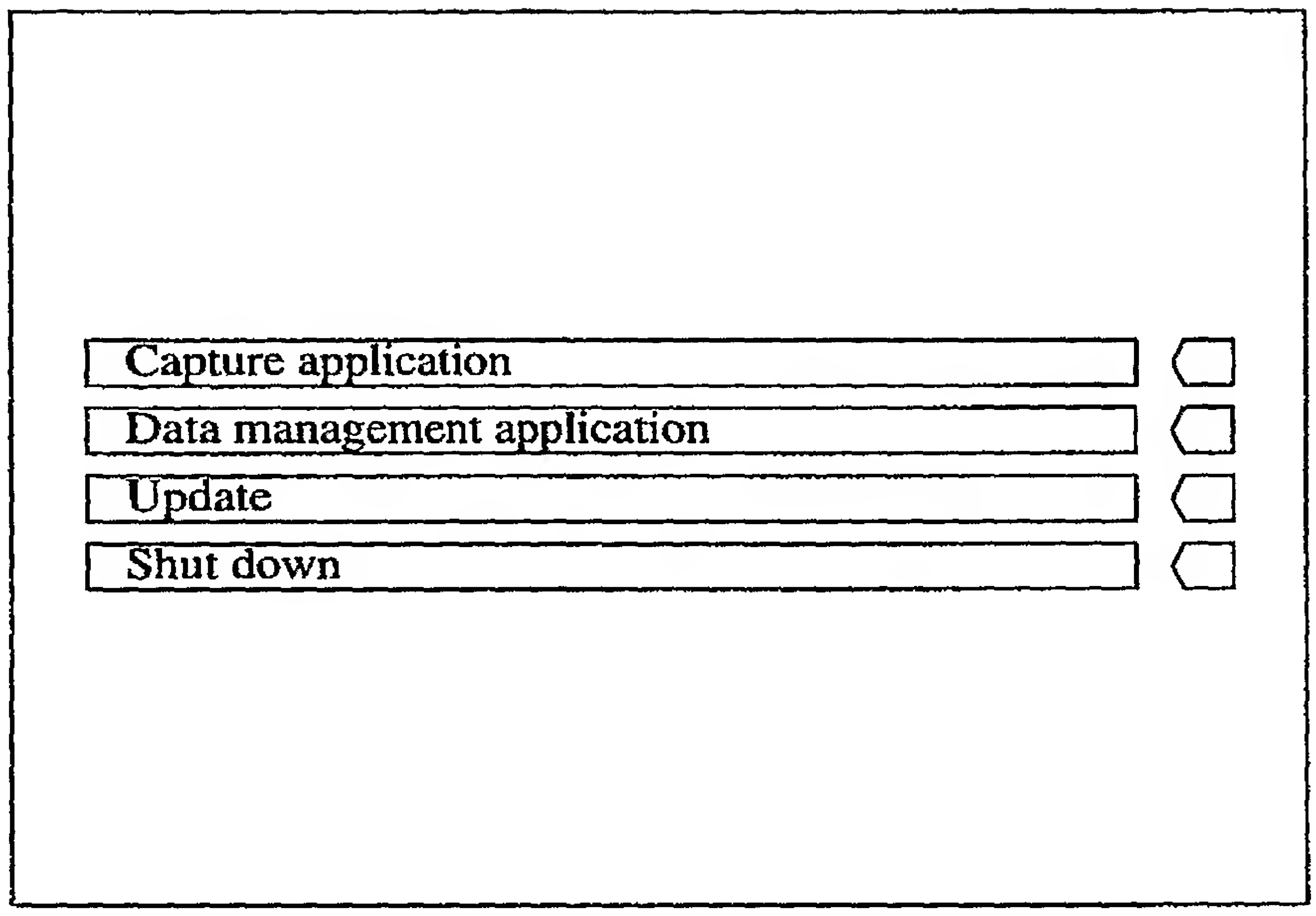


Figure 2.1: ChooseApp.

At boot the user chooses between the three applications. Depending on underlying operating system of the Control unit there may be an additional login prompt.

2.2 Capture application

2.2.1 Standard GUI components

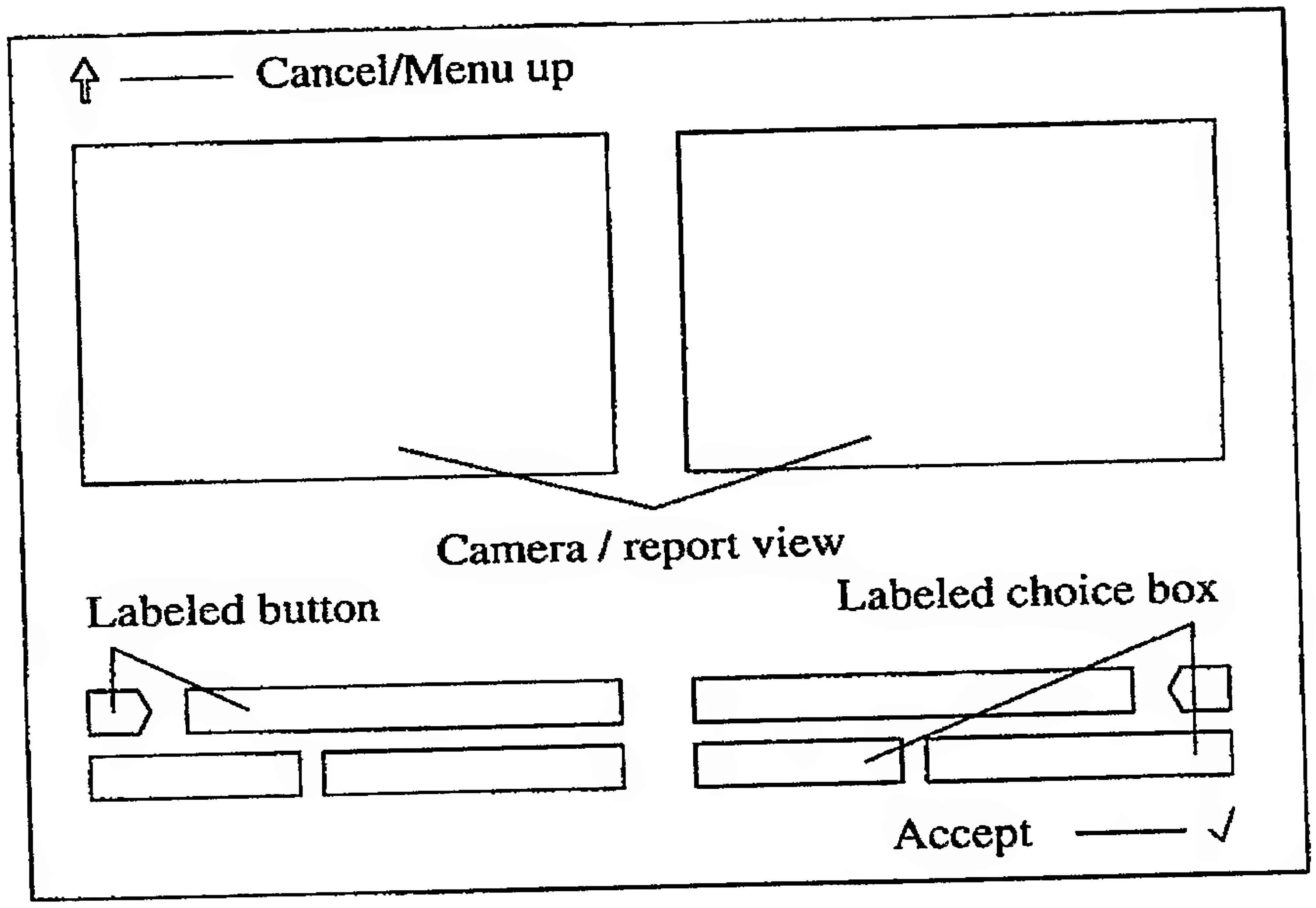


Figure 2.2: Capture application: Explain.

The GUI is built on a hierarchy of successive menus. By a menu is understood a frame embedded with a number of controls and views. Figure 2.2 shows generic components of each such menu. There are five main categories. Each menu is given a label of its theme.

1. Labeled button that leads to the next menu.
2. Labeled choice boxes (in some cases editable or just a plain editable text field).
3. Display of the camera view or a measurement report.
4. A button at the upper left to step up one level in the hierarchy of menus or cancel.
5. A button at the lower right to accept.

2.2.2 Mätbänk measurement

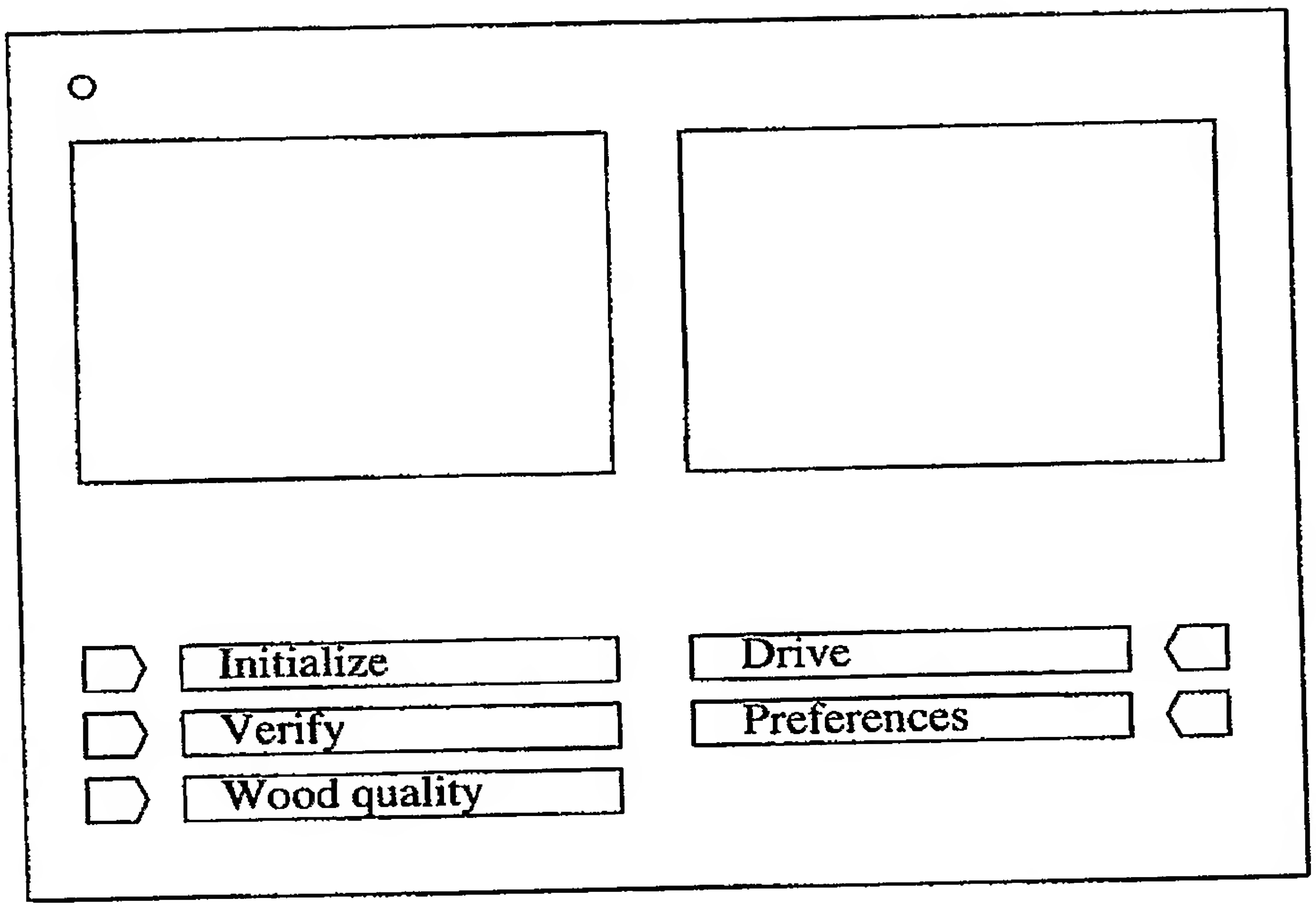


Figure 2.3: Capture application: MatbankMeasure.

This menu splits into

1. 'Initialize' for entering data for the mätbänk and adjusting cameras.
2. 'Drive' for driving along one side of a mätbänk.
3. 'Verify' for visual check of mismatches.
4. 'Preferences' e.g. for setting default measurement crew.
5. 'Wood quality' for entering wood quality assessment.

The two views are the camera views. The button at the upper right is for shutting down the system. The final set of preferences available from this menu item is left open and therefore no design is specified for the corresponding menu.

Initialize mätbänk

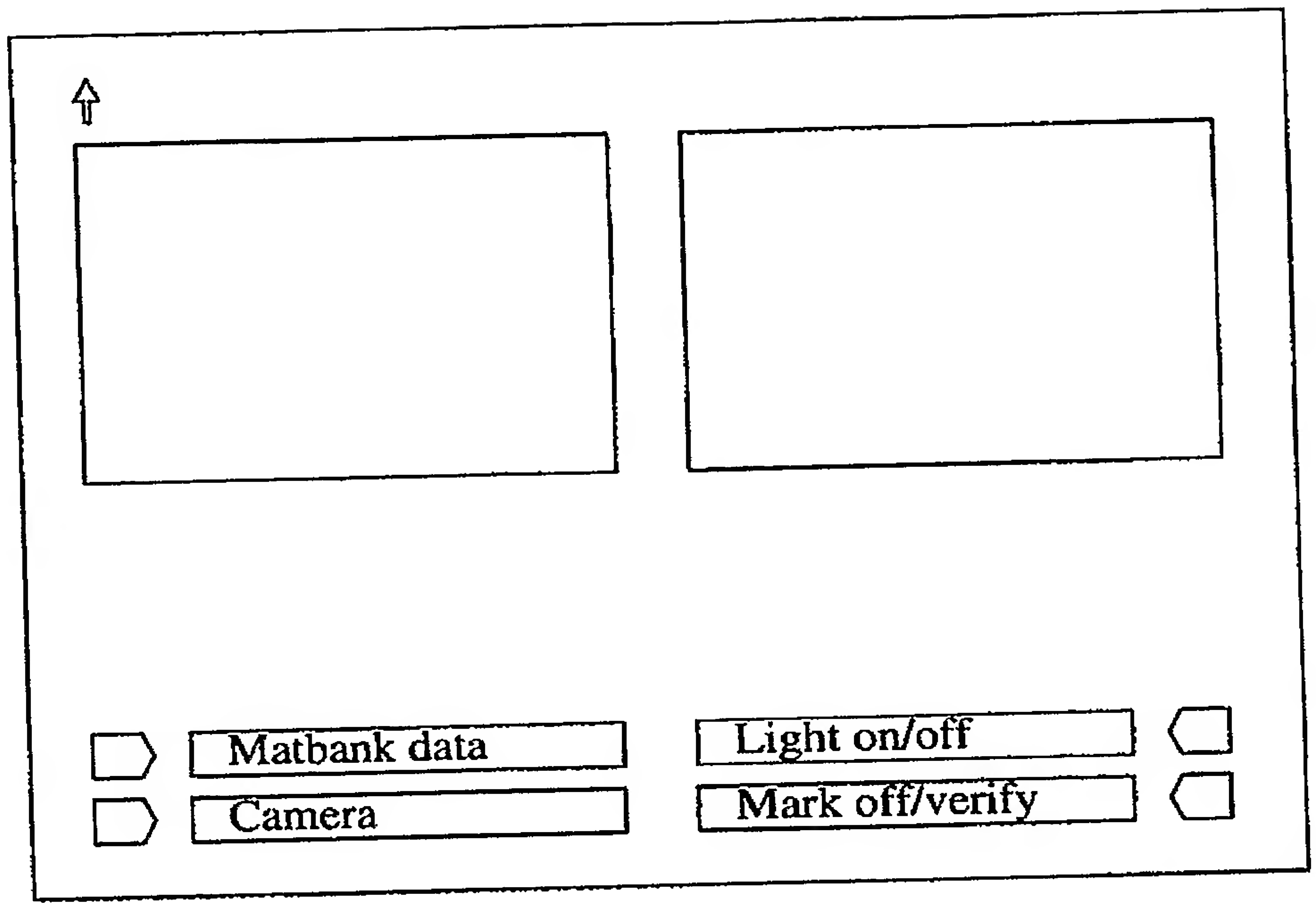


Figure 2.4: Capture application: MatbankInitialize.

This menu splits into

1. 'Mätbänk data' for specifying site, number of batches etc.
2. 'Light on/off' for powering the lights of the ICU on/off.
3. 'Camera' for camera adjustment.
4. 'Mark off/verify' for initializing the image analysis algorithm.

The two views are the camera views.

Mätbänk data

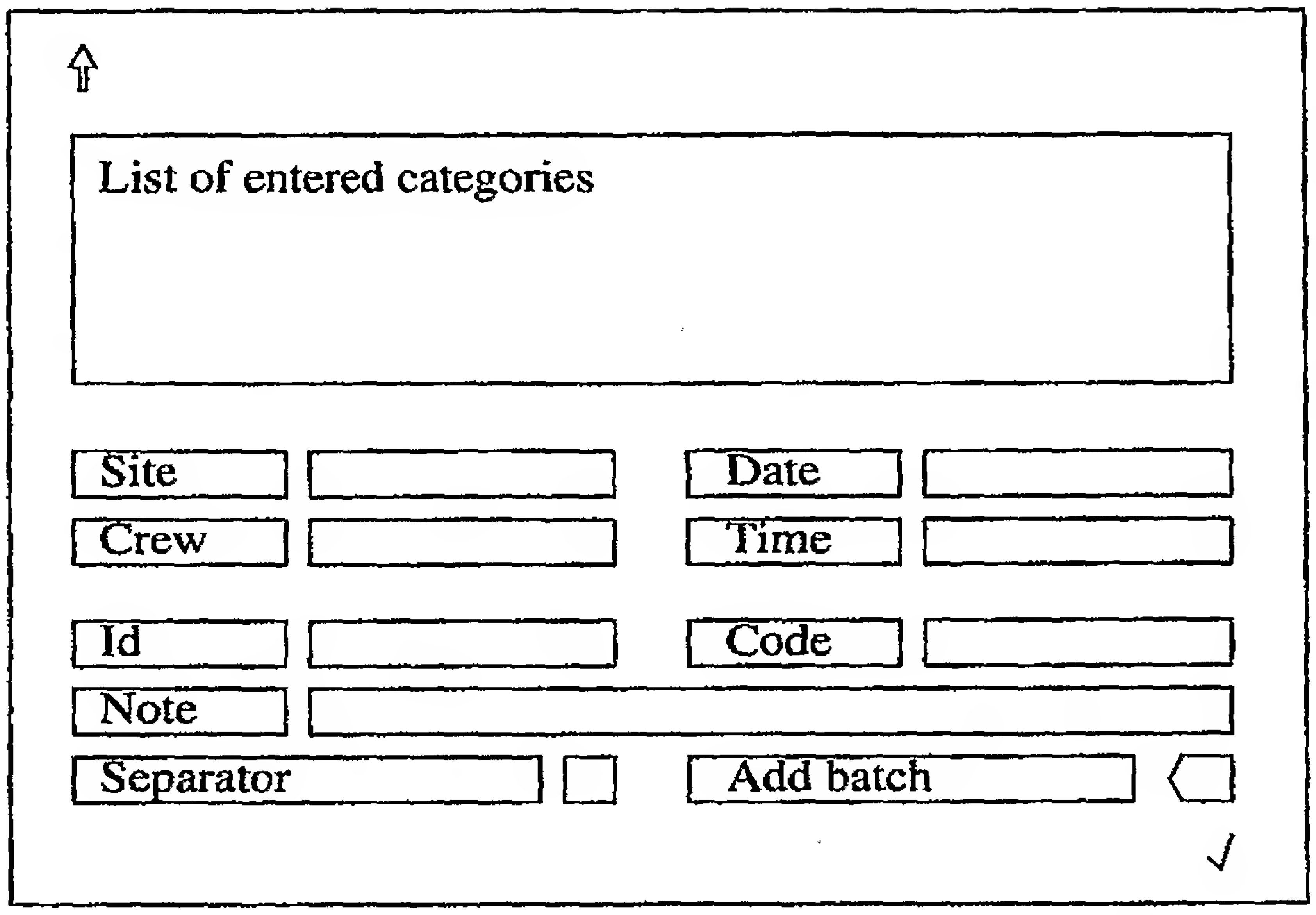


Figure 2.5: Capture application: MatbankData.

1. 'Site' is geographic location of mätbänk. Automatically preset by GPS unit and database. Choice box. Editable.
2. 'Date' is Julian date. Preset by system. Not editable.
3. 'Crew' is measurement personnel. Defaults to value set in preferences. Choice box. Editable.
4. 'Time' is the hour. Preset by system. Not editable.
5. 'Id' is for uniquely identifying batch. Text field. Editable.
6. 'Code' is assortment code by VMR. Choice box. Selectable.
7. 'Note' is for an optional note. Text field. Editable.
8. Check 'Separator' if batch separated by separator. Check box.
9. 'Add batch' stores the batch.

Camera adjustment

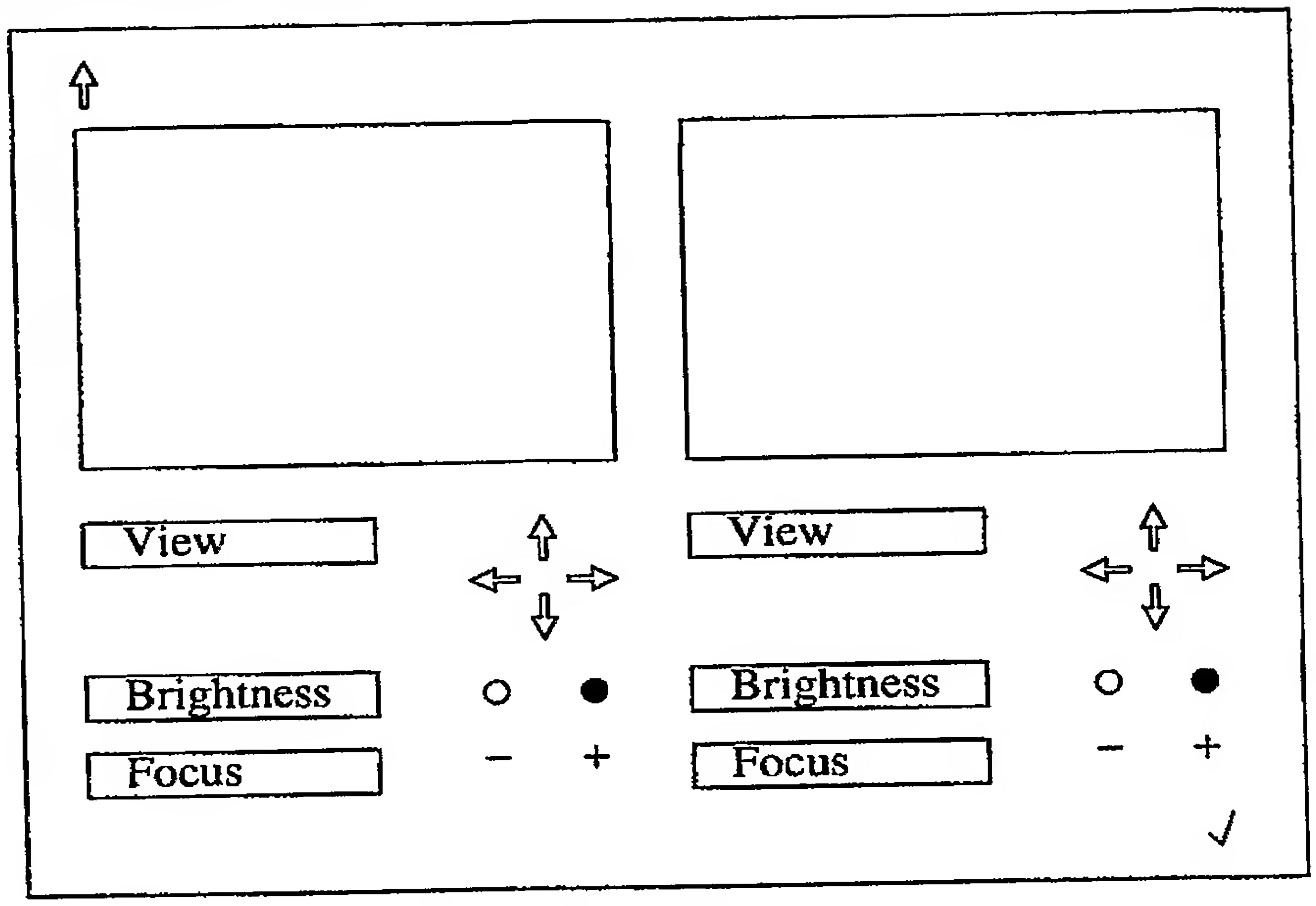


Figure 2.6: Capture application: Camera.

Menu for adjusting the two cameras of the stereo vision system.

1. 'View' is for adjusting the viewing direction of the cameras giving a proper field of view.

2. 'Brightness' for visual adjustment of brightness.

3. 'Focus' for visual adjustment of focus.

The actual controls of this menu may be different in the final implementation due to hardware choice.

The two views are the camera views.

INITIALIZE IMAGE ANALYSIS ALGORITHM

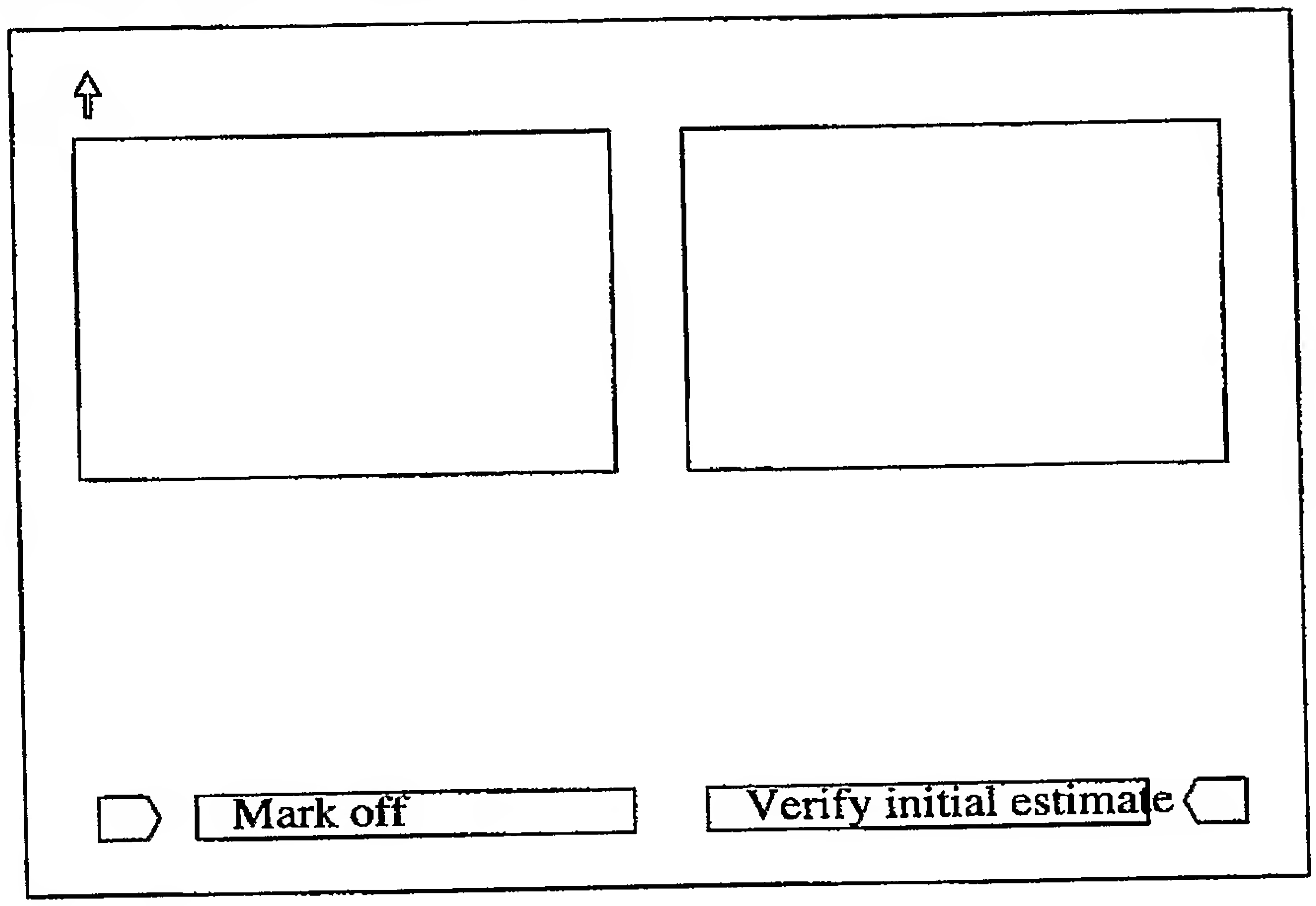


Figure 2.7: Capture application: MarkOffVerify.

This menu splits into

1. 'Mark off' for marking off the boundary of the logs/mätbänk at the starting position before start driving.
2. 'Verify initial estimate' to check that logs at the starting position are identified correctly.

The two views are the camera views.

Mark off boundary

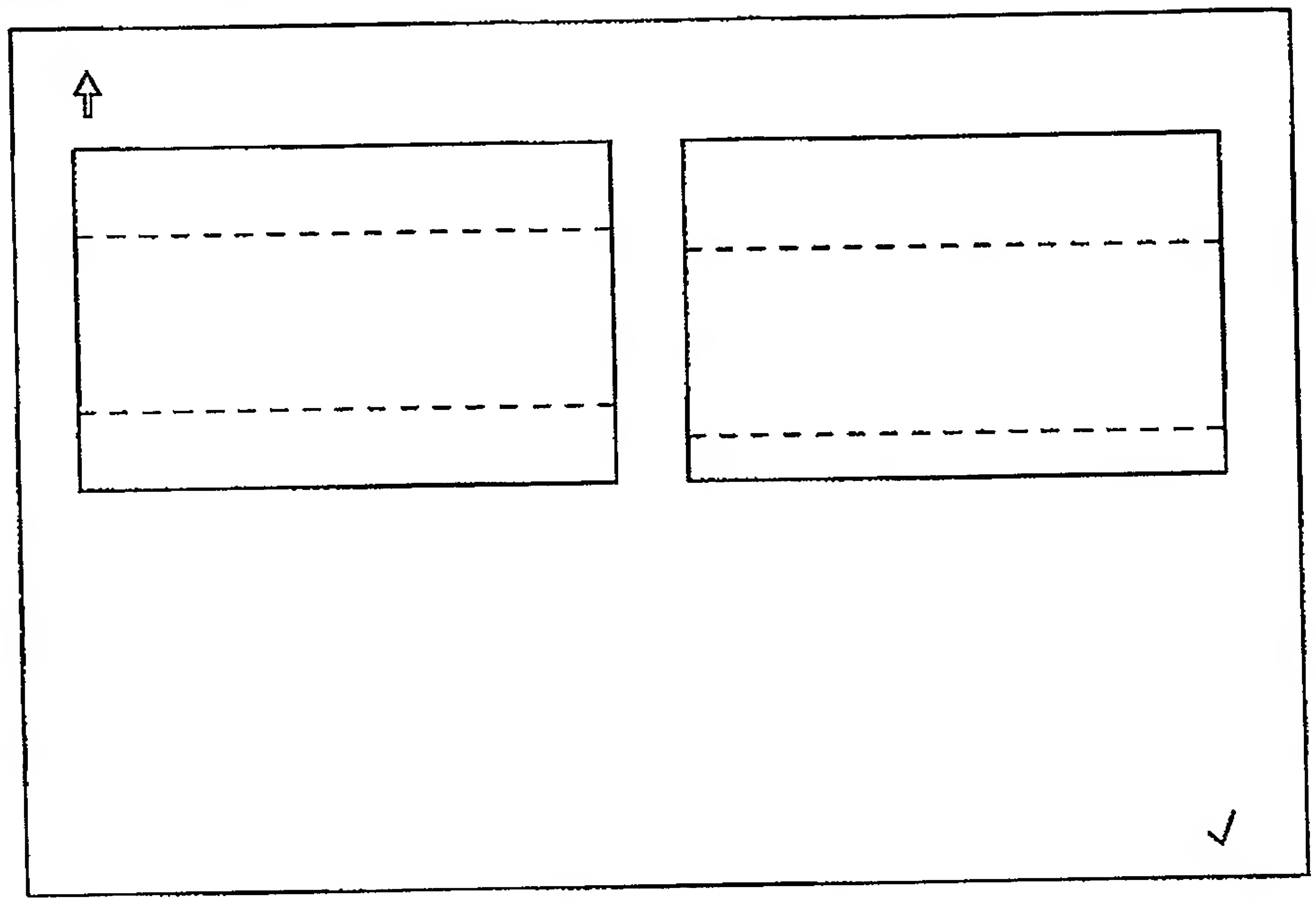


Figure 2.8: Capture application: MarkOff.

For marking off outline of logs and mätbänk while at starting position at side of mätbänk. Only a region of interest is to be marked off, not the individual logs.

The views are the two camera views. The superimposed dashed lines are dragged up and down by the user to mark off the outline. Other solutions are to draw on the display with a pen or using buttons to push the lines up and down. The choice is left open.

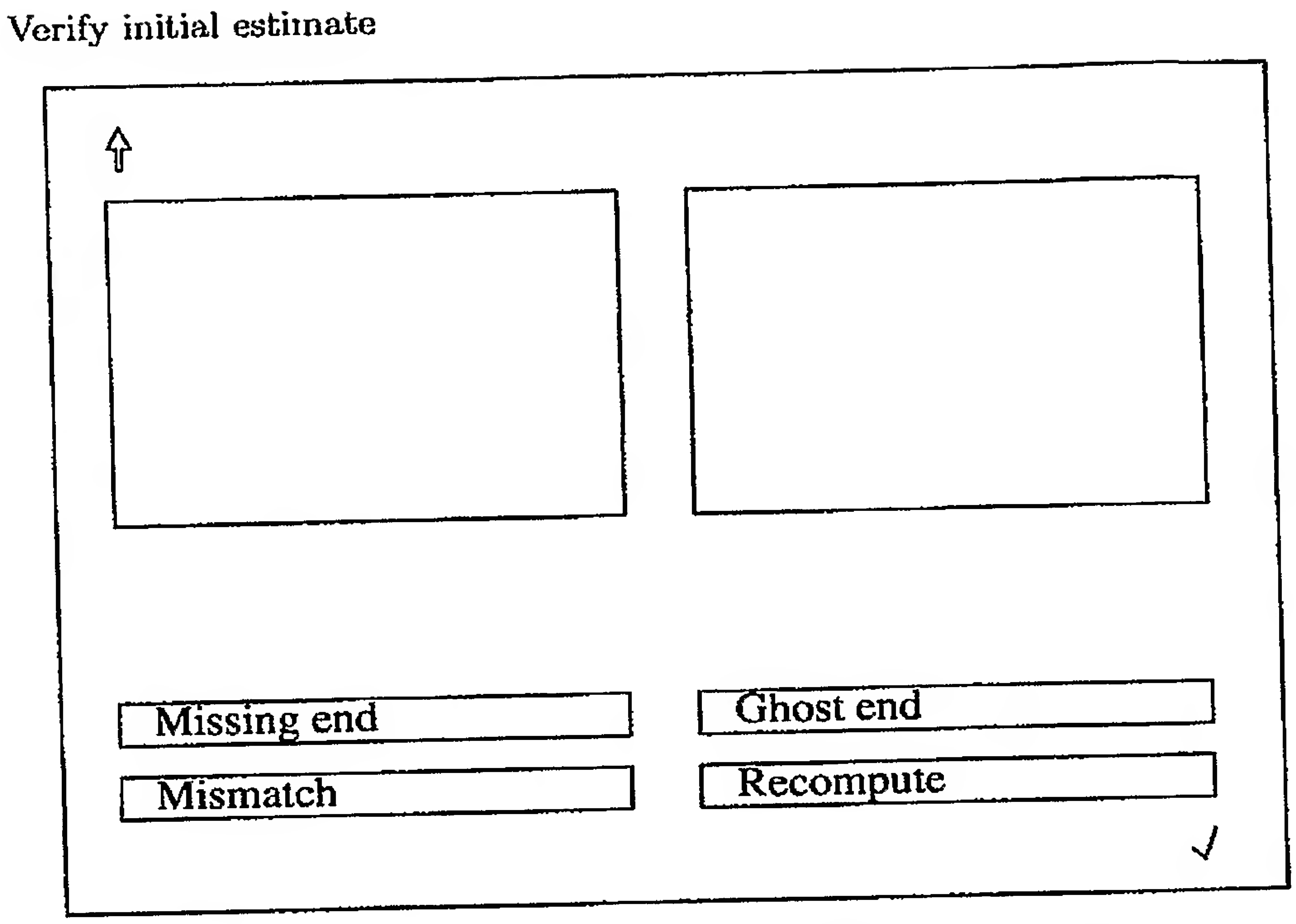


Figure 2.9: Capture application: VerifyInitialMatch.

The buttons changes the mode of the point and click interface.

1. 'Missing end' for pointing out a log end that is not detected.
2. 'Ghost end' for deleting a falsely detected log end.
3. 'Mismatch' for identifying logs whose ends are matched up incorrectly.
4. 'Recompute' reestimates the logs.

The views are the two camera views.

When doing the first drive ($A \to A'$) the 'Mismatch' button is not active since there is only imagery of the logs from one side.

The 'Mismatch' button may be implemented in different ways. One is simply to click at one log end and then the system automatically reruns the detection of logs. Another option is to point at the two ends that should match up and the system then reruns the detection. A third implementation is to have the user draw a line along the log that was incorrectly matched up. The actual choice of implementation is left open.

Drive

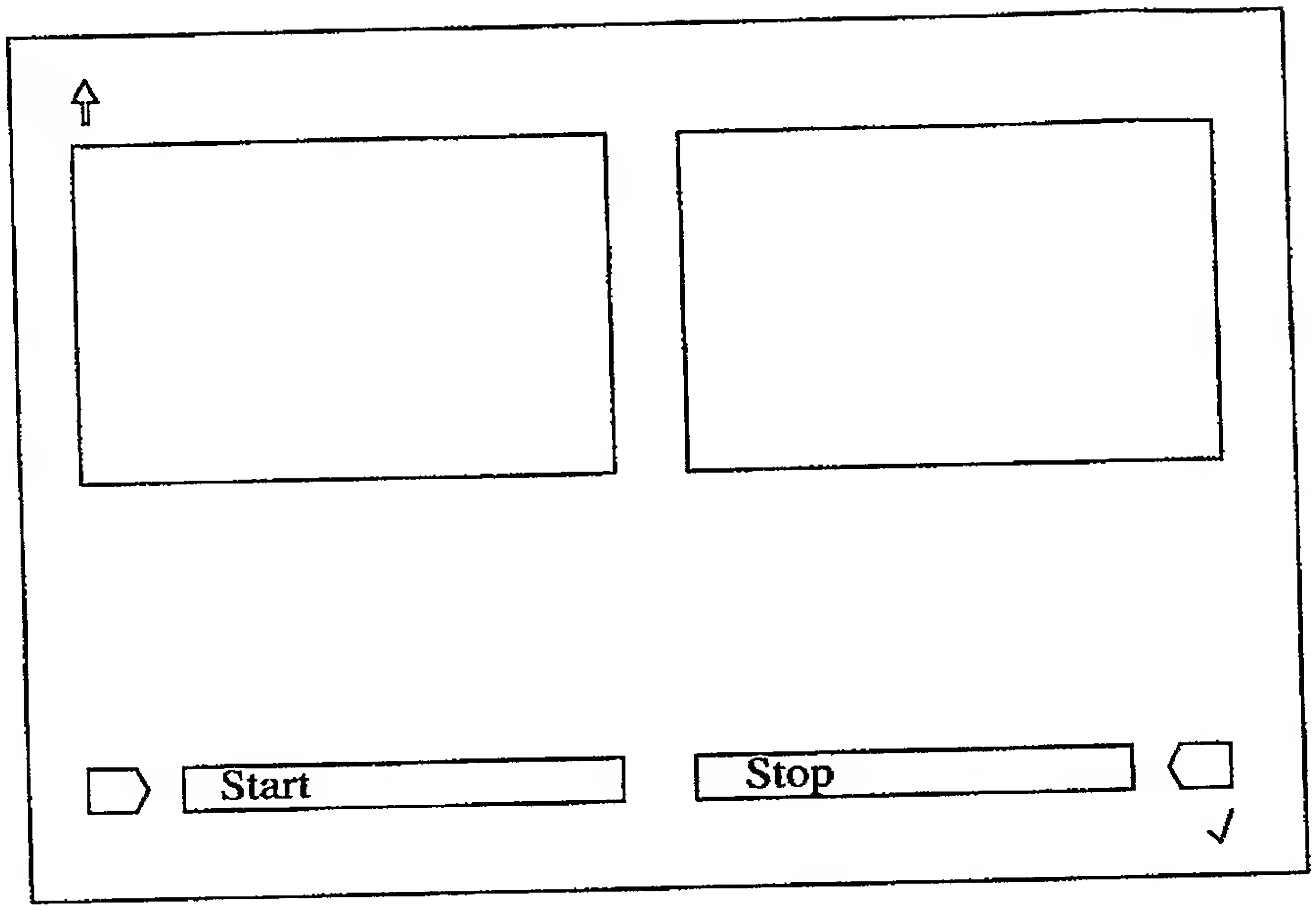


Figure 2.10: Capture application: Drive.

For driving along one side of mätbänk

1. 'Start' for activating the system when start driving.
2. 'Stop' for deactivating the system at end of mätbänk.

The views are the two camera views.

Verify

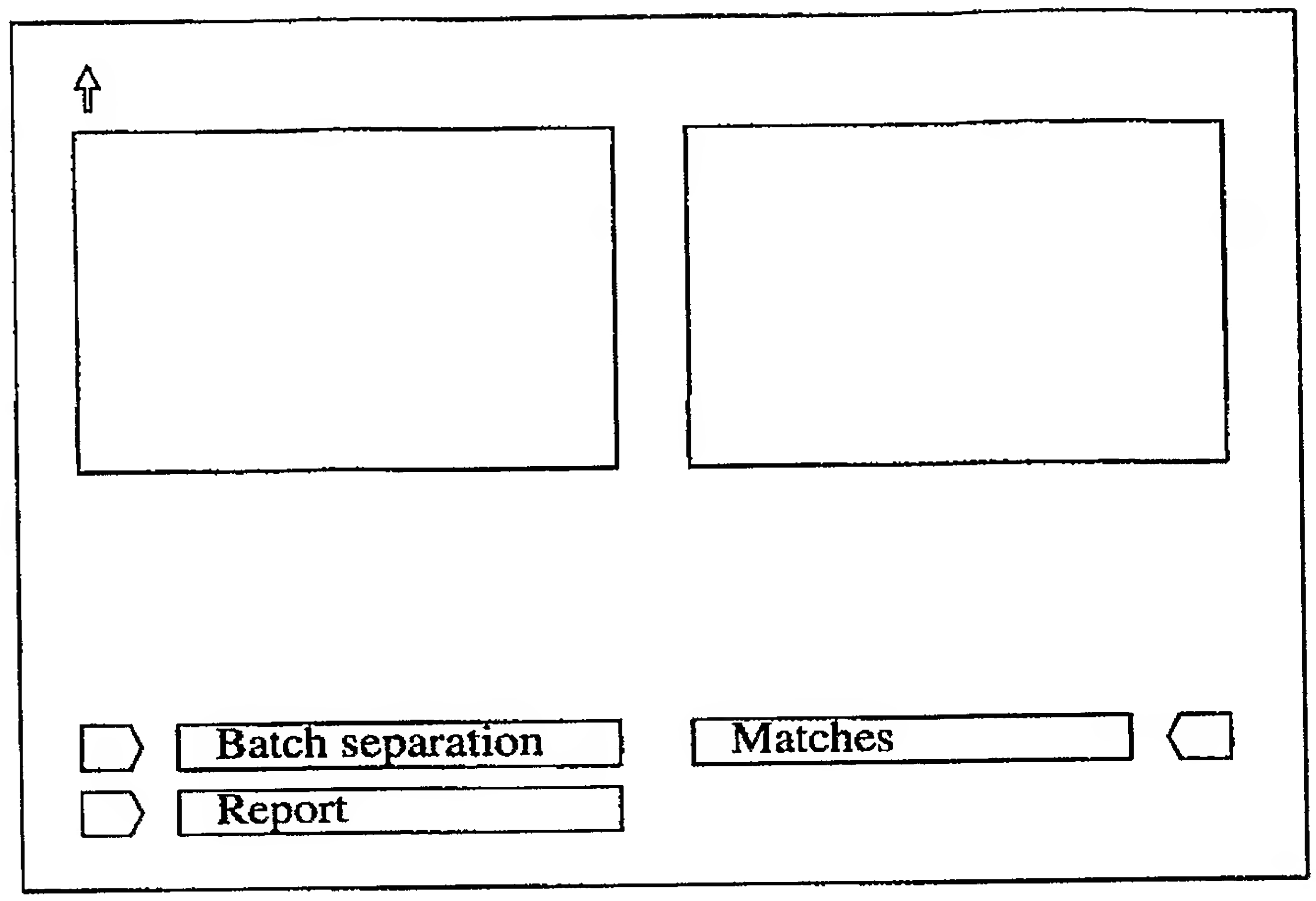


Figure 2.11: Capture application: VerifyBatch.

For verifying the overall estimate of the current mätbänk.

1. Use 'Batch separation' to verify that batches on the mätbänk are separated correctly.
2. Use 'Matches' to verify that all logs are matched up correctly.
3. Use 'Report' to print preliminary report on the display.

The views are the two camera views.

VERIFY BATCH SEPARATION

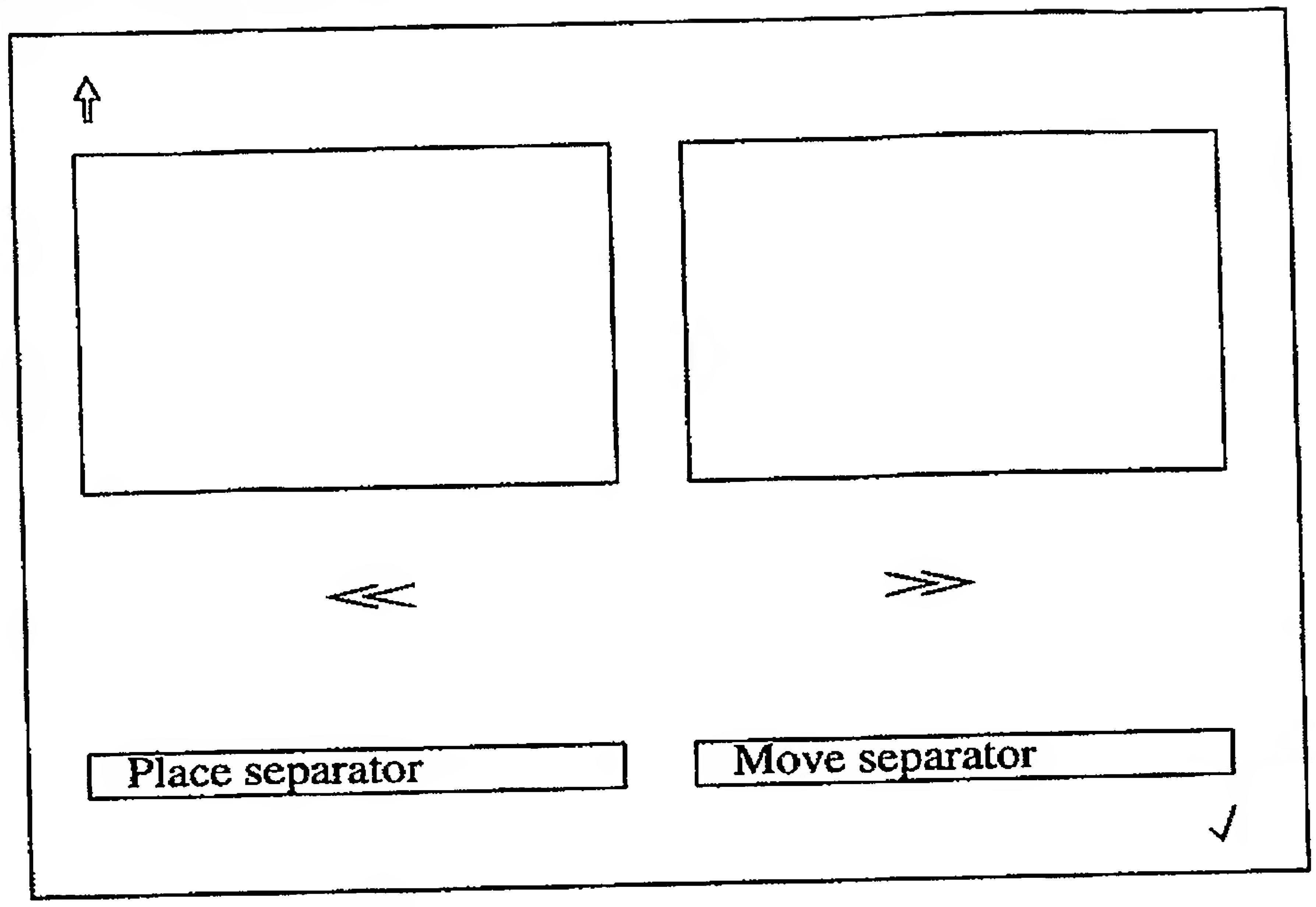


Figure 2.12: Capture application: VerifyBatchSeparator.

The two buttons 'Place separator' and 'Move separator' changes the behavior of the cursor.

1. 'Place separator' to place a separator between batches on mätbänk.
2. 'Move separator' to move a separation between batches on mätbänk.
3. Use '<<' and '>>' to play the image sequence backward and forward.

If batch separators were signalled by use of landmarks, this system detected seperations will be pre-entered. As for the menu for verifying the initial estimate, the interface for placing and moving a separator may be implemented in several ways. The actual implementation is left open.

VERIFY MATCHES

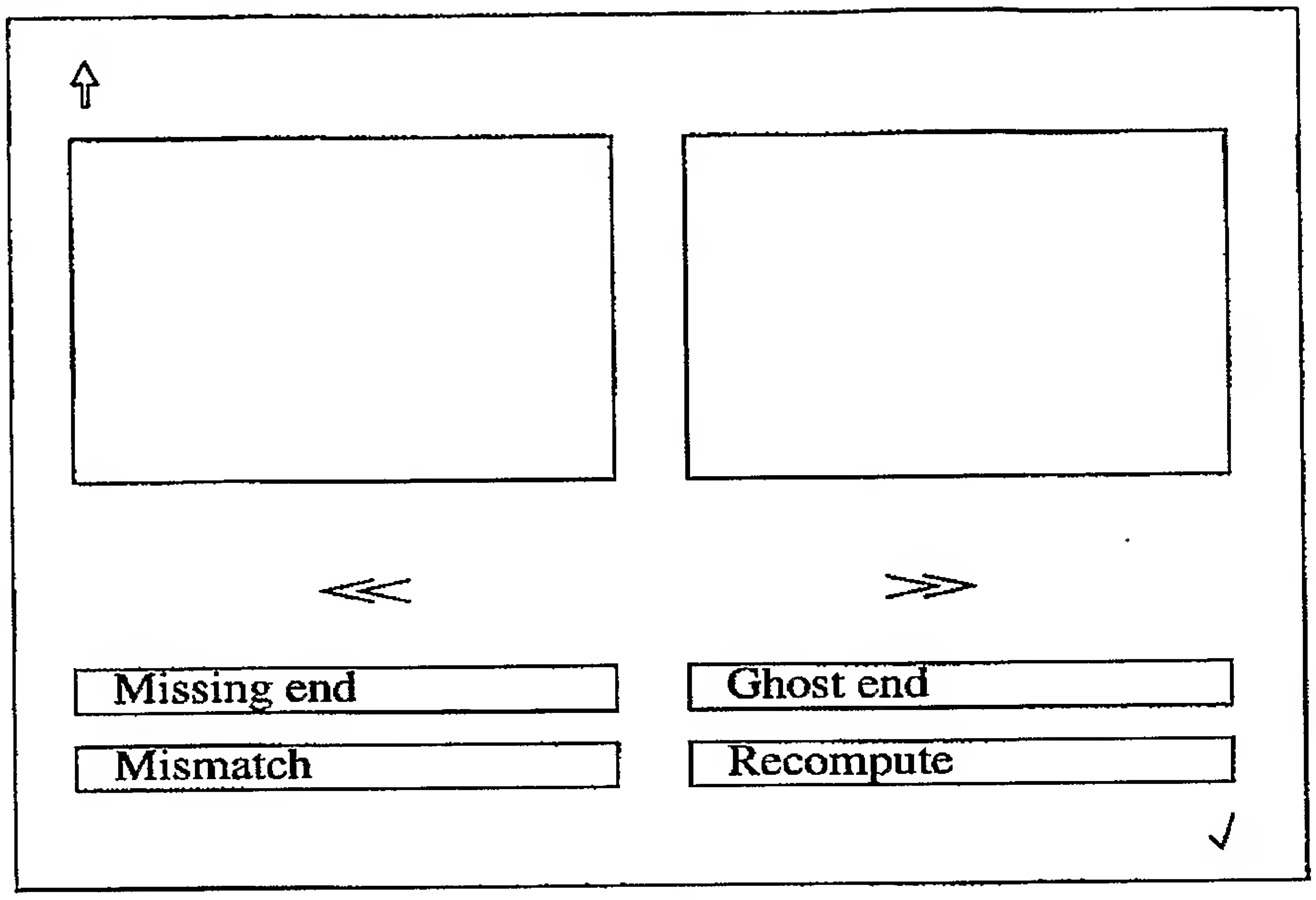


Figure 2.13: Capture application: VerifyBatchMatch.

Identical to the menu for verifying the initial estimate except for the buttons '<<' and '>>' for playing the image sequence backward and forward.

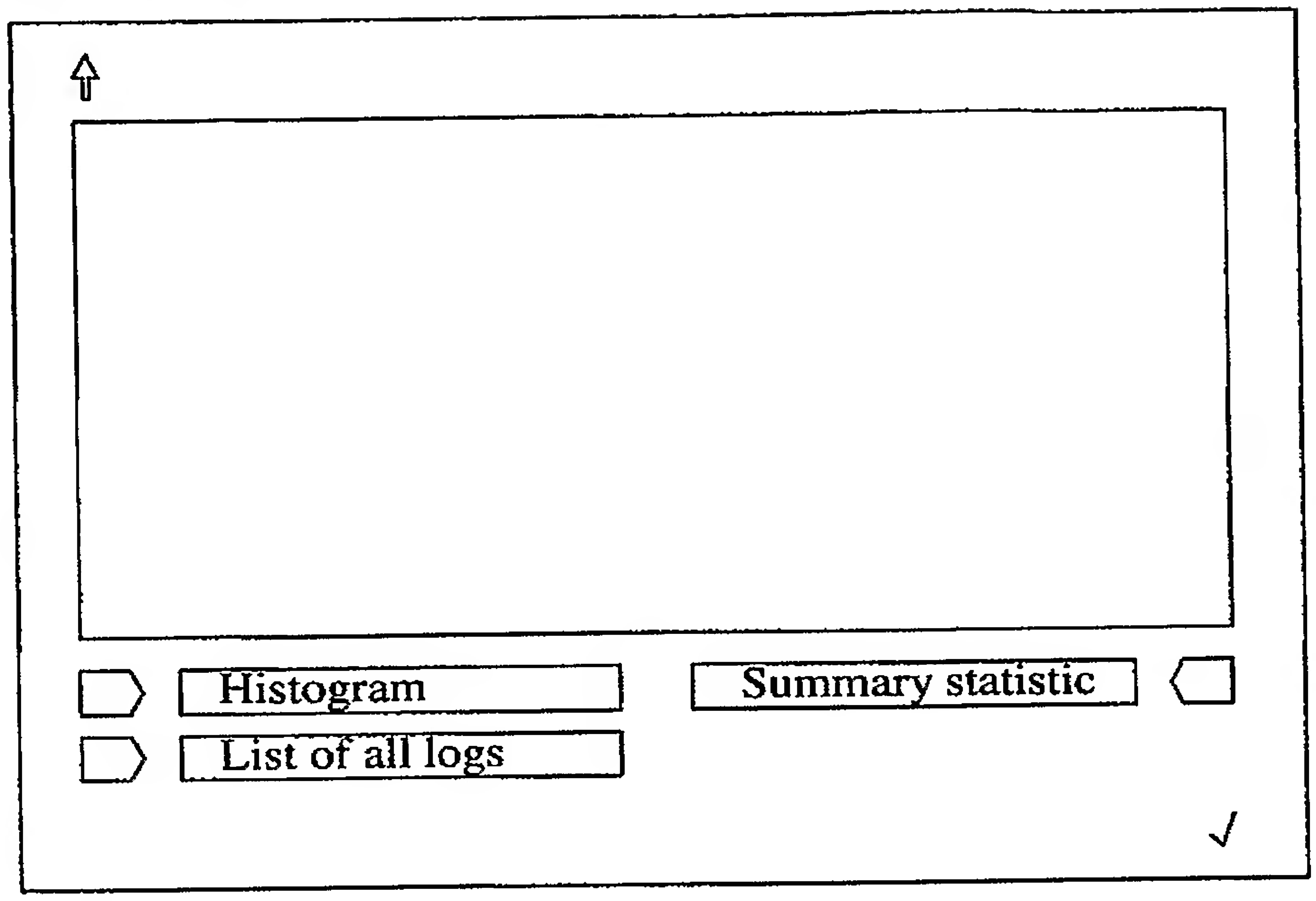


Figure 2.14: Capture application: Report.

This menu splits into

1. 'Histogram' for bringing histograms to display.
2. 'Summary statistic' for bringing tables of summary statistics to display.
3. 'List of all logs' a detailed list of statistics for each individual log on the mätbänk.

The view is the view of the various graphics produced for the report.

Wood quality

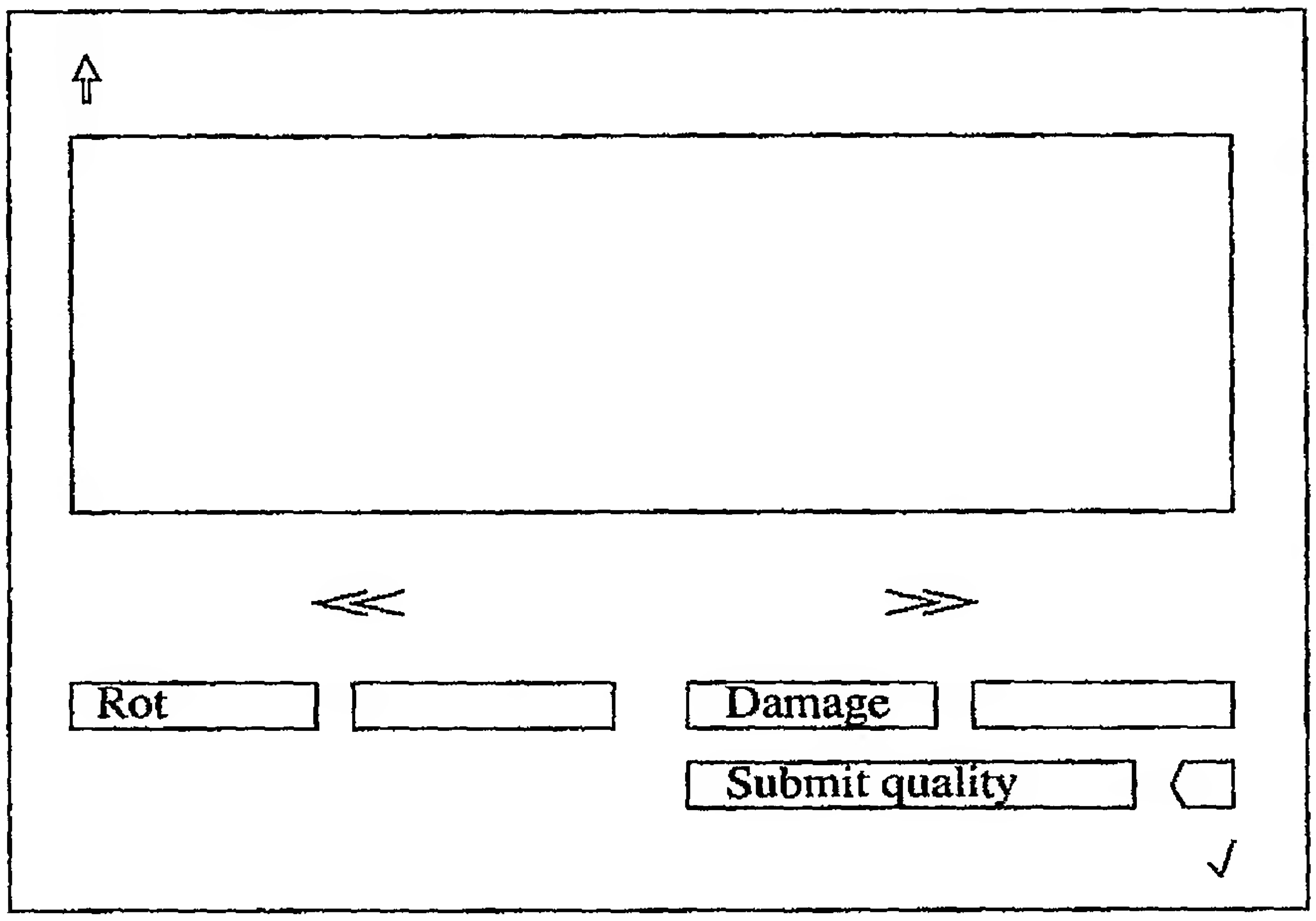


Figure 2.15: Capture application: WoodQuality.

The menu splits into

1. 'Rot' is percentage rot. Textfield, row of radio buttons or slider. Editable.

2. 'Damage' is percentage damage. Textfield, row of radio buttons or slider. Editable.

The categories Rot and Damage are preliminary. The actual categories and information to enter should equal the quantities recorded today.

The view is a combined view of imagery from the image sequence and summary statistics that shows information on the logs at display and location of the imagery on the mätbänk to help the user identify the log being assessed.

2.3 Data management application

The design of the Data management application follows a standard GUI based on Windows (Figure 2.16). The body of the window will display summaries and graphics related to the actual data chosen.

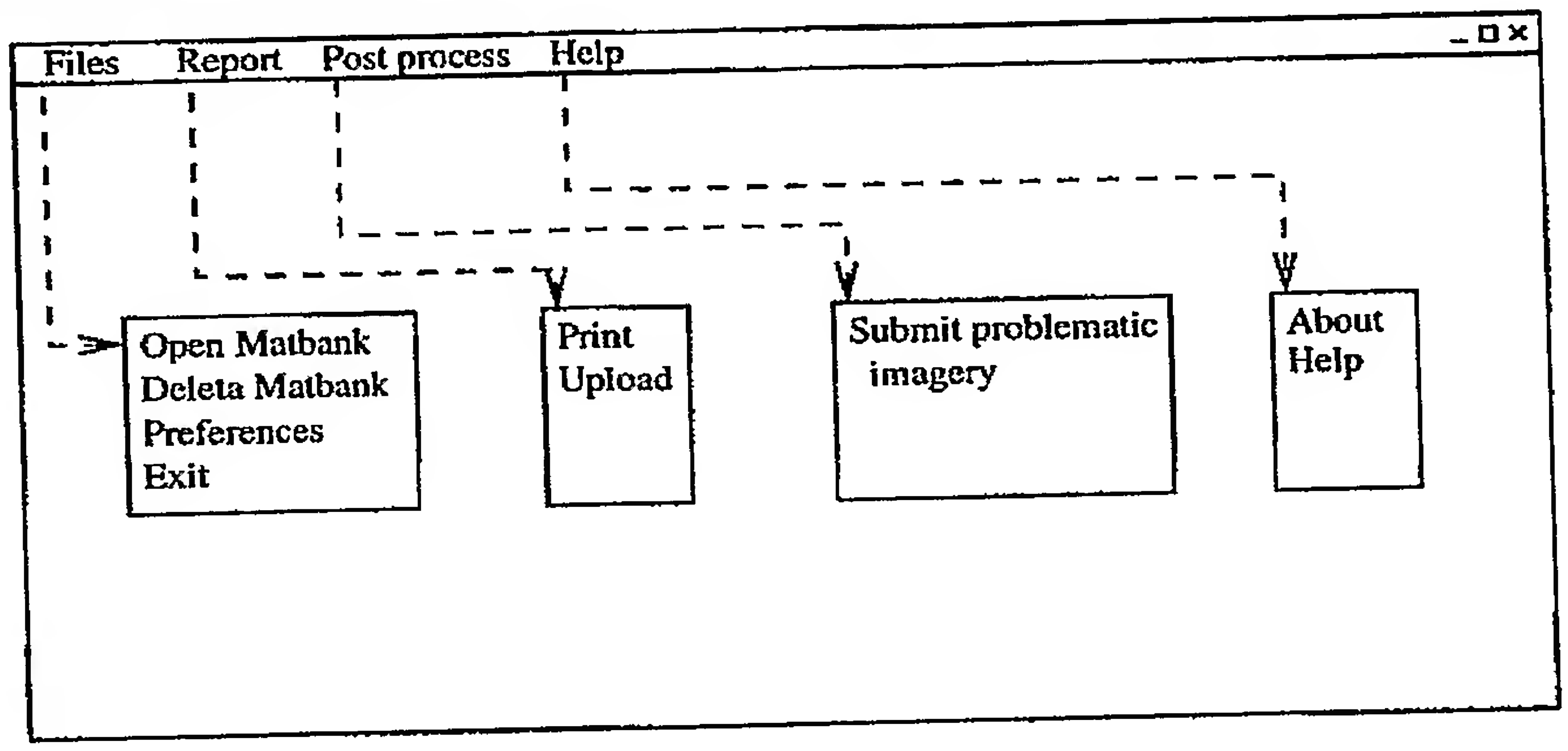


Figure 2.16: Data management application: MainFrame.

The items of the 'Files' menu are

1. 'Open Mätbänk' opens a pop-up window with a browser/chooser facility to choose the data to work with.
2. 'Delete Mätbänk' to free up space on the user control. The data to delete is chosen through a browser/chooser as in 1.
3. 'Preferences' for setting preferences. The preferences may relate to hardware settings of the Image capturing unit, network connections, report formats and algorithms used. The exact set of preferences available is left open.

   The preferences are set through a tabbed pop-up menu.
4. 'Exit' for exiting the Data management application.

The items of the 'Report' menu are

1. 'Print' for printing the mätbänk data chosen to paper.
2. 'Upload' for uploading data to central server.

The item 'Post process' is

1. 'Submit problematic imagery' for submitting problematic imagery to DRALLE APS (cf 8b of Table 1.2). The system issues warnings and guides the user to identify such imagery if any.

The 'Help' menu includes

1. 'Help' for help on the system.
2. 'About' for version etc of the system.

2.4 Update application

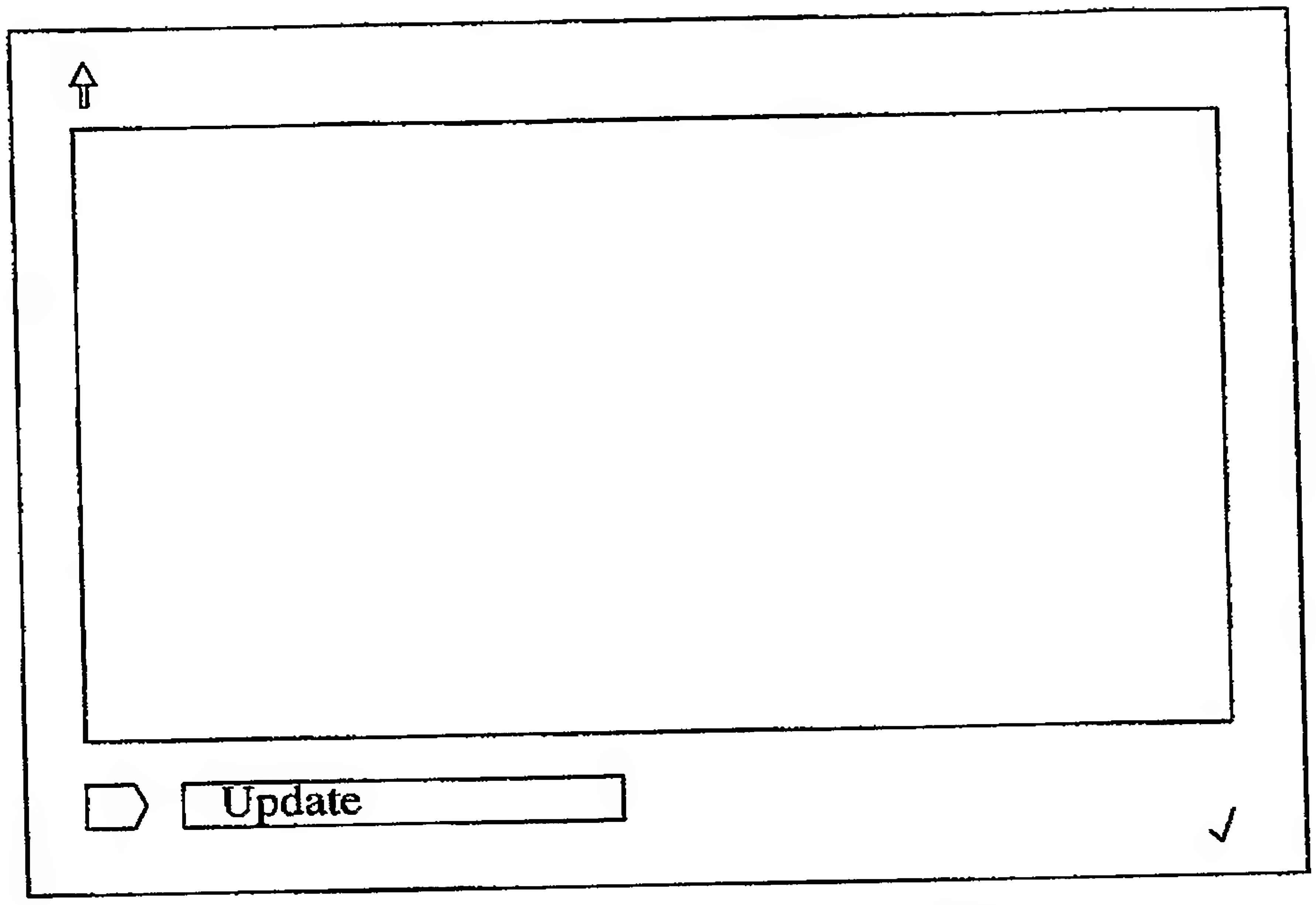


Figure 2.17: Update application: Update.

For software updates.

1. 'Update' starts the software update.

The view is the log for the installation of the update. Software updates make take place through a web based service or from a distributed medium like a CD. The actual procedure is left open.